FINAL TECHNICAL REPORT / RAPPORT TECHNIQUE FINAL

SCALING UP POSTHARVEST MANAGEMENT INNOVATIONS FOR GRAIN LEGUMES IN AFRICA

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IDRC Grant / Subvention du CRDI: 108157-001-Scaling Up Post-Harvest Management Innovations for Grain Legumes in Africa

Project Name:	Scaling up Postharvest Management Innovations for Grain Legumes in Africa

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List of Acronyms

AGRA	Alliance for a Green Revolution in Africa
CEAS	Centre Ecologique Albert Schweitzer
CLAPHI	Catalyzing Large Scale Adoption of Cowpea Post-Harvest Innovations for Enhanced Prosperity and Food Security in Burkina Faso
COPAZA	Small Commercial Farmers Association
DRAAP	Provincial Directorates of Agriculture and Hydraulic Development
FBO	Farmer Based Organizations
GAPI	Sociedade de Investimentos – Página Inicial
IDRC	International Development Research Centre
ISSER	Institute of Statistical Social and Economic Research (ISSER)
IDRC	International Development Research Centre
PHTs	Post-Harvest Technologies
PICS	Purdue Improved Cowpea Storage
PHLs	Post-Harvest Losses
SCFs	Small Commercial Farmers
TECAP	Thresher company
WEAI	Women's Empowerment in Agricultural Index

Executive summary

African farmers are striving to increase their crop yields, but lose most of their production due to inappropriate post-harvest management processes. The problem of food loss in sub-Saharan Africa is acute: more than 30% of the food produced for human consumption across the continent is lost owing to inadequate post-harvest management, lack of structured markets, inadequate storage in households and on farms, and limited processing capacity. With more than 70% of Africans drawing their livelihoods from agriculture, finding sustainable solutions for post-harvest losses holds tremendous promise for enhancing regional economic growth and well-being. Over the last decade, many actors working in the African agricultural development landscape have developed a set of potential solutions for post-harvest management of agricultural value chains. Some of these are: Purdue Improved Crop Storage (PICS) bags; Metal silos; Chemical use; Hermetic cocoons; threshers; Plastic barrels among many others. Today, a major effort is needed to drive these known solutions to scale in ways that reach millions of farmers and through business models that will ensure long-term sustainability through the public and private sectors.

With support from International Development Research Center (IDRC) over a period of 36 months, AGRA and its implementing partners implemented an applied research project to bring effective, field-tested innovations for increasing productivity and reducing post-harvest loss of soya bean (soybean) and cowpea to thousands of smallholder farmers in Mozambique and Burkina Faso respectively. The project tested different scaling up models with private and public sector partners while different financing mechanisms were explored that would enable smallholder farmers access these technologies. **The overall objective of the project is to catalyze and sustain large-scale adoption of post- harvest value addition innovations for grain legumes in Mozambique and Burkina Faso**, with the following specific objectives:

i) Scale up innovative post-harvest technologies (PHTs), specifically threshers and PICS bags, to achieve meaningful impacts in the lives of farmers, women and youth; and
ii) Assess the effectiveness of select delivery models for the chosen innovations; and
iii) Synthesize and disseminate evidence and lessons from the scaling efforts to catalyze the field and inform policy change and investment.

Guided by these objectives, AGRA worked with TechnoServe, as the project implementing partner in Mozambique (to implement activities in upper Zambézia, northern Mozambique, more specifically in Gurué district), backed by COWI as the research partner on soybeans and with GRAD Consulting Group in Burkina Faso (to implement activities the Mouhoun region specifically Sourou and Nayala), backed by Institute of Statistical Social & Economic Research (ISSER), University of Ghana, as the research partner on cowpea intervention. These partners were supported by a team of thematic experts from AGRA (Markets, Finance, M&E, Knowledge management, Extension, Gender).

Over the project period, various results were realized. Under project objective one - *Scale up innovative post-harvest technologies (PHTs), specifically threshers and PICS bags, to achieve meaningful impacts in the lives of farmers, women and youth*, the following are key results:

- Scaling up of use of PICS using agro-dealers as the delivery channel, and threshers using private sector actors, all which benefitted a total of 4929 smallholder farmers (SHFs) in Burkina Faso. This resulted in a decline in the post-harvest losses between baseline and end-line. Total post-harvest losses of the cowpea grains were observed to decline from an average of 20.87kg at baseline to 14.13kg at end-line per farmer household surveyed (46.8% reduction)

- 12 artisans trained to fabricate threshers and fabricated 19 in Burkina Faso, all of which have been sold
- Tested the threshers innovation in Mozambique via import of ready machines and this benefitted 20 Small Commercial Farmers (SCFs), all of whom are women;
- Trained a total of 7,229 in post-harvest technologies (3,300 in Mozambique and 4,929 in Burkina Faso). Farmer based organizations (FBOs) with membership of 8,000 smallholder farmers were supported through capacity building on better use and benefits of PICS bags technology and linked to 35 agro-dealers. Using this model, 32,000 PICs bags were sold through the agro-dealers;
- Reduction in drudgery. Traditional threshing of soybeans is manual in most of Mozambique, requiring 3 man-days of 10 laborers to thresh 1,000kgs of soybeans; this is replaced by project mechanized threshers with a capacity of 1,500kg/hr, and
- Increased business opportunities and access to finance/credit: For instance in Mozambique, 15,866 MT of soybean sold through aggregation centres at a value of $4,683,617. In regards to credit access, SCF accessed $56,000 from GAPI (Sociedade de Investimentos – Página Inicial) in loans to finance the threshers. In Burkina Faso, the volume of cow pea sold through aggregation centres is 1,712 MT valued at $787,603. Input loans accessed was $45,200. Credit received through warrantage stood at $103,636.

Under objective 2, - *Assess the effectiveness of select delivery models for the chosen innovations*, the project was guided by two key research questions: i) what is the most effective way of accelerating the adoption of soybean and cowpea post-harvest management technologies? and ii) what is the economic and social impact of increased use of post-harvest technologies (PHTs)?

Towards accelerating adoption of PICS and threshers, the project established that the most effective way of scaling up the use of technologies was through training, demonstrations and structuring the distribution system through use of agro-dealers, especially for PICS. For machines, the project determined that demonstrations of threshers with stakeholders was most effective to incentivize procurement and ultimate use of the machines. From the adoption of PICS and threshers in Burkina Faso, farmers who used PICS bags and stored produce in the FBO managed aggregation centers were able to reduce post-harvest loss in storage from 30% at baseline to 9% at end line (3 years), (70%). This is much higher than 46.8% at household level, attributed to good warehouse management and quality control at aggregation centers.

In regards to social and economic impact of use of technologies, a number of gains have been noted.

- As a result of reduced losses and high quality, farmers were able to access institutional markets like World Food Program (WFP) and SONAGESS (national food reserve agency) of Burkina Faso;
- Because of availability of mechanized threshers, on average, farmers in Mozambique were able to increase the area under soybean production on average from 5ha to 21ha, and this is also driven by high demand for soybean by the poultry feed industry;
- In Mozambique, the project established that soy milk and other derivatives of soy appear to be well accepted locally. In the long run, this may imply that an increased use of soy could diversify the local diet and boost the nutrition level of local population.

In regards to objective 3 - *Synthesize and disseminate evidence and lessons from the scaling efforts to catalyze the field and inform policy change and investment*, the project organized various dissemination events including: validation workshops with stakeholders in Mozambique and Burkina Faso to share results and received feedback on the project; the manuals developed by the project on post-harvest management in Burkina Faso have been adopted by the Directorate of Agriculture for dissemination for use by extension officers country wide; engagement with Purdue University on key results and lessons and this resulted in increasing the number of PICS distributors from 1 to three to serve the key cow pea growing regions of

Burkina Faso; data from the project is feeding into the Burkina Faso Ministry of Agriculture reports working with DRAAP(Direction Provinciale de l'Agriculture et des Amenagements Hydrauliques), policy advocacy to reduce duties and taxes on PICS bags, or include them in input subsidy package started, and in Mozambique, the project had a conference event with all soybean value chain actors to share experiences of the soybean value chain opportunities for scale up; amongst others. Videos and success stories of the project have been shared with stakeholders. The project team is also in the process of developing journal articles, policy briefs and knowledge nuggets in the year. These will be disseminated widely through different channels including website links, publications, and in post-harvest management events.

Key lessons emerging from the implementation of this project include the following:

- Scaling up mechanized post-harvest services by private sector offers huge opportunities for the reduction of post-harvest loss, reduction of drudgery, creation of jobs and ultimately an agricultural transformation. This implies developing appropriate partnership with the private sector
- Collective marketing through aggregation centres was proven effective in linking farmers to markets especially the institutional buyers. Emerging from this is the value of structured markets that will have the ripple effect of enhancing productivity and adoption of post-harvest technologies
- To accelerate the adoption of PHTs, more affordable technologies should be available in the market and have appropriate infrastructure for sales and after sales services and maintenance.

The research problem

African farmers are striving to increase their crop yields, but lose most of their production due to inappropriate post-harvest management processes. The problem of food loss in sub-Saharan Africa is acute: more than 30% of the food produced for human consumption across the continent is lost owing to inadequate postharvest management, lack of structured markets, inadequate storage in households and on farms, and limited processing capacity1. With more than 70% of Africans drawing their livelihoods from agriculture, finding sustainable solutions for postharvest losses holds tremendous promise for enhancing regional economic growth and well-being.2

Over the last decade, many actors working in the African agricultural development landscape have developed a set of potential solutions for post-harvest management of agricultural value chains. Some of these are:

- Purdue Crop Storage bags(PICs) bags
- Metal silos
- Chemical use
- Hermetic cocoons
- Threshers
- Plastic barrels among many others

Today, a major effort is needed to drive these known solutions to scale in ways that reach millions of farmers and through business models that will ensure long-term sustainability through the public and private sectors.

With support from IDRC and over a period of 36 months, AGRA and its implementing partners undertook a project to support applied research to bring effective, field-tested innovations for increasing productivity and reducing post-harvest loss of soya bean (soybean) and cowpea to thousands of smallholder farmers in Mozambique and Burkina Faso respectively. The project tested different scaling up models with private and

[1] In general, losses are greatest for fruits and vegetables (50% and more), then roots and tubers (~40%) and in the range of 20% for grains and cereals (IFDC cited in Rockefeller Foundation, 2015).

[2] World Bank: www.data.worldbank.org 2015

public sector partners and proven delivery mechanisms. Different financing mechanisms were explored that would enable smallholder farmers access these technologies.

The overall objective of the Project is to catalyze and sustain large-scale adoption of postharvest value addition innovations for grain legumes in Mozambique and Burkina Faso, with the following specific objectives:

1. Scale up innovative post-harvest technologies (PHTs), specifically threshers and PICS bags, to achieve meaningful impacts in the lives of farmers, women and youth;
2. Assess the effectiveness of select delivery models for the chosen innovations; and
3. Synthesize and disseminate evidence and lessons from the scaling efforts to catalyze the field and inform policy change and investment.

Guided by these objectives, AGRA worked with TechnoServe, as the project implementing partner in Mozambique, backed by COWI as the research partner on soybeans and with GRAD Consulting Group in Burkina Faso, backed by Institute of Statistical Social & Economic Research (ISSER), University of Ghana, as the research partner on cowpea intervention. These partners were supported by a team of thematic experts from AGRA (Markets, Finance, M&E, Knowledge management, Extension, Gender).

The following were the guiding two research questions:

1. What is the most effective way of accelerating the adoption of soybean and cowpea post-harvest management technologies?
2. What is the economic and social impact of increased use of post-harvest technologies (PHTs)?

The outcome of this work is expected to add to the body of knowledge on this key pressing problem and inform policy makers on pathways to scale.

Project research implementation areas

In Burkina Faso, The project was implemented in the Boucle du Mouhoun region's two provinces of Nayala and Sourou

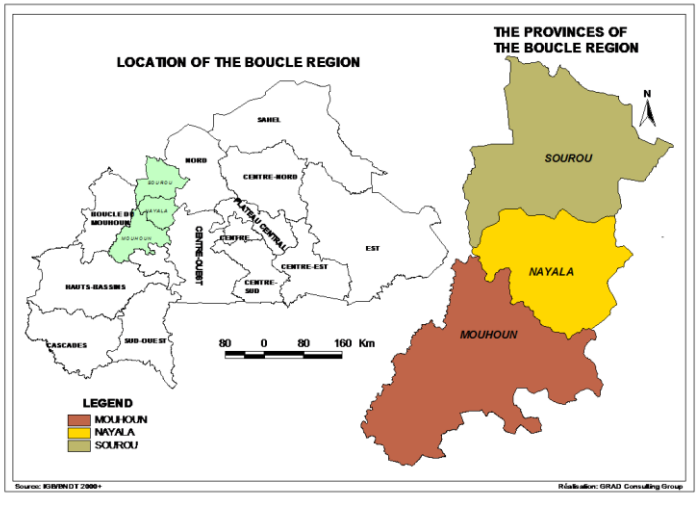


Figure 1: Region of the Boucle du Mouhoun and the target provinces of Sourou and Na In Mozambique, the project implementation area was Gurué District Zambézia Province, and Malema province for comparison study

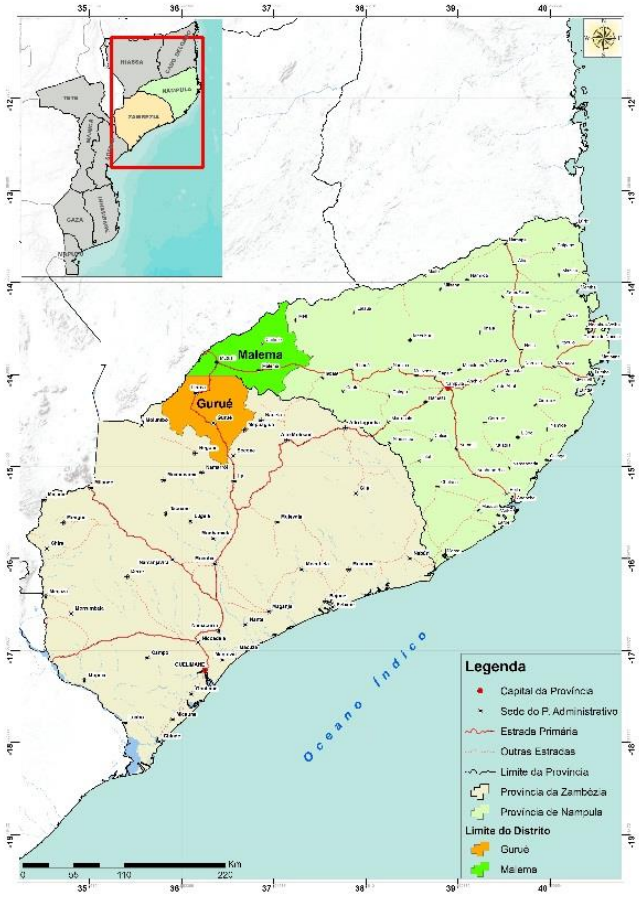


Figure 2: Project implementation area Gurue and Malema, Zambesia Province

Progress towards milestones

After a 36-month implementation period, the project managed to achieve most of the milestones with some challenges, some weather related, insecurity in project implementation areas in Mozambique and in Burkina Faso and late delivery and poor performance of imported threshers in Mozambique. A summary is presented below and discussed in detail in further chapters of this report

Major milestones achieved include:

1. Feasibility study on soy-based products in Mozambique undertaken:
   A study commissioned to evaluate the use and potential to scale soy products in Mozambique reported limited use by the communities except soy flour that is used in bakery products. Soy milk was the second product mainly promoted by NGOs targeting women groups. Soybean is a high value crop and demand from the animal feed industry, especially poultry feed manufacturers is prioritized

2. Delivery models for post-harvest technologies developed:
   4 delivery models for PICs distribution were evaluated: distribution through Agrodealers; private integrated service providers; farmer based organizations (FBOs); and government extension officers. Agrodealers were found to be the most effective and sustainable channel compared to the other three.

3. A youth engagement strategy developed and implemented

The youth strategy is based on the concept of "Virtual Youth center" that leverages ICT to connect the youth to opportunities and enablers in the agricultural sector. AGRA is working to fine tune this strategy in Burkina Faso, Mozambique, Nigeria and Tanzania. A deep dive study in these countries identified the incentives, opportunities and barriers to youth engagement in agriculture and policy changes necessary for the youth to respond to market opportunities.

4. Ex ante adoption potential and impact projection of PHTs completed:
   The adoption potential and impact projection for PHTS in the two countries was captured in the baseline studies, monitoring studies and endline studies carried out throughout the project implementation period. These are expounded in the chapter on results and outcomes.

5. Business models for operators and origination models that integrate PHTs are developed and implemented: models that train artisans to fabricate threshers and to link them to finance and market were tested in Burkina Faso, while in Mozambique Small Commercial Farmers (SCF) were linked to financial institutions for asset financing and markets
6. A plan for evaluating reduction in PHL at different points of the chain developed and implemented at midline: Results on PHL loss reduction is discussed in detail in the results and outcomes chapter.
7. Cost-benefit analysis studies and beneficiary surveys implemented: studies on threshers returned positive results with a payback of 100 days threshing in Burkina Faso and 120 days in Mozambique
8. Linkages between SCFs, operators, and financial service providers established and US$ 113,000 mobilized through private entrepreneurs and financial institution to fund the acquisition of post-harvest handling equipment (threshing machines), were established with GAPI in Mozambique and Coris Bank and RCPB Bank (Reseu des Caisses Populaires du Burkina) in Burkina Faso
9. Policy makers, private sector, researchers and other key stakeholders have access to information, through project data feeding into the Ministry of Agriculture reports in Burkina Faso, thresher operation and maintenance manual shared and extension messages shared on the M-Farm platform, while in Mozambique, a conference on " Experiences from Developing the Soybean Value Chain in Mozambique" brought stakeholders together to map the growth of this value chain and opportunities to scale
10. Study on the economic magnitude of post-harvest losses in the Mozambican soy industry undertaken during the monitoring studies, indicating highest losses are at threshing stage
11. Project activity data and achievements against targets are discussed under results and outcomes.

Synthesis of research results and development outcomes

The overall objective of the Project is to catalyze and sustain large-scale adoption of postharvest value addition innovations for grain legumes in Mozambique and Burkina Faso.
In this chapter the scaling models tested in each country are reviewed and research findings on PHL technologies adoption, loss levels and cost benefit analysis of using threshers is discussed.

Objective1. Scale up innovative post-harvest technologies (PHTs), specifically threshers and PICS bags, to achieve meaningful impacts in the lives of farmers, women and youth;

AGRA and its implementing partners (GRAD and TechnoServe) took a two-pronged approach to address the above objective in the two countries; in Burkina Faso this objective put an emphasis on two technologies;

hermetic storage using PICS bags and a multi-functional thresher. To scale out PICS bags, focus was on demonstration and trainings of beneficiaries. Structuring the PICS supply chain through the appointed distributor (BOUTAPA) to expand the distribution network and appoint agro-dealers as distribution agents to get PICS closer to the farmers. On threshers, local fabrication was preferred in Burkina Faso, while in Mozambique, the threshers were imported from Brazil to be used by Small Commercial Farmers (SCFs) who would provide services to smallholder farmers at a fee. .The implementing partners worked with smallholder farmers and the private sector to test the models. The research partners- ISSER in Burkina Faso and COWI in Mozambique carried out the research work ; baseline, monitoring endline studies and impact evaluation of the project in each country. Scaling post-harvest models:
In Burkina Faso, the project tested two post-harvest loss reduction models, mainly hermetic storage bags and mechanized threshing of cowpeas, while in Mozambique only the threshers were tested.

1.1. Hermetic storage bags

Hermetic storage bags and specifically Purdue Improved Crop Storage (PICs) bags, have been tested widely in Burkina Faso on cowpeas storage by Purdue University and found to be effective in reducing post-harvest losses of cowpeas during storage due to the hermetic condition they create if well used. This storage model however has not gone to scale with wide adoption among farmers. The project explored delivery channels that could be effective in reaching thousands of farmers and equipping them with knowledge.

1.2. Mechanized threshing of cowpeas and soybeans

In most African countries threshing of cowpeas and soybeans is undertaken manually with resultant high losses and drudgery for the operators. Use of mechanized threshers was tested and loss reduction along the threshing process captured to inform improvement. In Burkina Faso, the project trained local artisans to fabricate threshers while in Mozambique the threshers were imported from Brazil and threshing services provided through the Small commercial farmer (SCF) model.
Small Commercial Farmer (SCF) model focused on emerging farmers and/or trusted existing local small agribusinesses. TechnoServe trained, supported, and equipped these SCF to deliver the necessary inputs, extension, mechanization, and other services like land preparation and threshing to smallholder farmers (SHFs) on a commercial basis. As part of the community, these local service providers share a relationship with SHFs beyond the business partnership. They are also well-placed to encourage the adoption of new, locally-appropriate seeds and technologies, and to facilitate smallholder farmer access to key input and output markets. This sustainable model has proven to be profitable, efficient, and responsive to local SHF needs.

Project results and outcomes in each country are discussed below:

Burkina Faso results and outcomes:

Cowpea is one of the most important agriculture commodity in Burkina Faso given its important role in food/nutritional security and the resilience of communities and in income generation (huge institutional and consumer market demand). Burkina Faso produces 600,000 MT of cowpeas annually. However, many constraints are hampering the cowpea value chain contribution to rural livelihoods. This includes post-harvest losses during threshing and storage due to manual threshing which is putting a lot of workload on women and also to the high pest (bruchids weevils) sensitive nature of cowpea grains. Furthermore, the high transaction cost of marketing small quantities of grains that is spread among numerous smallholders and the poor quality of grain that went through inadequate post-harvest handling are constraining cowpea market access.

The project was implemented in two provinces of Boucle du Mouhoun region; Nayala and Sourou, chosen for high cowpea productivity and market players. The project used Farmer Organizations (FBOs) as entry point in each province. Following a thorough profiling exercise, four (4) FBOS were selected as beneficiaries, with 8,000 members. These FBOs were trained and coached in numerous and various topics including leadership; group dynamics and marketing. A local facilitator was hired within each FBO as an agent of change to support

innovation process within the FBOs. The project facilitated the drafting of business plans for each FBO for 2017-2019.

The project target to reach 5,000 farmers with various post-harvest technologies and demonstrations were exceeded, with a high participation of women (over 65%).

Summary of key results achieved:

No. of farmers registered on Mfarms ICT platform	6,612 (83% women)
No. of farmers trained in post-harvest loss management	4,929 (99% of target)
No. of farmers using PHL technologies	4,427 (89%)
Post-harvest loss in storage (aggregation centers) (target 10%)	9%
No. of Agrodealers trained to distribute PICS bags	35 (70% of target)
No. of demonstrations on Good Agricultural Practices	126
No. of farmers participating in demonstrations	5,597 (66% women)
Volume of cowpea sold through aggregation centers	1,712MT
Value of cowpea sold through aggregation centers	$787,603
Input loans accessed	$45,200
Credit received through Warrantage system	$103,636
No. of local thresher fabricators trained	12
No of threshers fabricated and sold	19 (target 20)
Jobs created from threshing services	49 (122% of target)

Table 1: Key project data

1.1.1. Scaling out PICs bags in Burkina Faso

The use of PICs bags in Burkina Faso provided farmers with a tested secure storage product. But getting the adoption to scale has been a challenge. One of the key problems has been the accessibility of the PICs bags near farmers, and distances farmers travelled over 50km to get genuine PICS from the appointed distributor-BOUTAPA. The other problem encountered was the poor understanding among farmers on how to use the triple layer PICs bags. The project designed approaches that could overcome the challenges of accessibility and awareness as discussed below:

a. Training of farmers and service providers:

To overcome the poor accessibility of PICs bags, the project trained 35 agro-dealers (service providers), including one woman, on the benefits of PICs bags and how to use them. This helped them explain to farmers the right way to use the PICs. The Agrodealers were linked to the approved distributor BOUTAPA for bulk purchases to supply farmers. The distributor (BOUTAPA) is the appointed agent of the manufacturer (Fasoplast). Discussions with Purdue University resulted in two distributors appointed, reducing distances farmers travelled to get PICS to about 17km.

Farmer based organizations (FBOs) with membership of 8,000 smallholder farmers were supported through capacity building on better use and benefits of PICS bags technology and linked to the 35 Agrodealers. Using this model, 32,000 PICs bags were sold through the Agrodealers. To further increase awareness of PICs use among cowpea growing farmers, tours were carried out in the 14 communes of Sourou and Nayala for demonstrations of PICS bags, either through training or awareness-raising events. French and local language radio advertising spots were broadcast. Various tools were developed and used to sensitize and train the beneficiaries. These included training manuals, posters, short videos, flyers and e- registration on Mfarms ICT integrated digital platform. Through the Mfarms platform, farmers received market information, extension

advice through voice and text messages. 109 demonstration sessions with 4,750 farmers, (69% women), participated in the PICs awareness campaigns. FBOs stored their members' aggregated produce in PICs and were able to access markets from large institutional buyers like World Food Programme (WFP) and the national food reserve agency SONAGESS.

Figure 3: Demonstration/ training on use of PICS

1.2.1. Scaling of threshing services

In Burkina Faso, the project intended to scale out existing threshing machines which are often imported. 15 local artisans were selected through their national chamber of artisans. They were allowed to build on an existing machine designed by Africa Rice that was modified to meet the project purpose and thresh multiple crops (cowpea, maize, rice, sorghum, millet). 12 artisans from 7 provinces (major hubs including Bobo-Dioulasso, Ouagadougou, Dedougou, Kaya, Ouahigouya, Koudougou, and Fada N'gourma) of Burkina Faso were involved in the process of training and action research at the Centre Ecologique Albert Schweitzer (CEAS). The first two machines that were fabricated were taken to the field for testing and fine tuning. A second training was organized to incorporate the field feedback to improve the machines through design modification. The fabricated machine was able to handle multiple crops including cowpeas, rice, sorghum and maize. The progress on the threshers development received a lot of support from the Regional Directorate for Agriculture and Hydraulics Development (DRAAP) of the Boucle du Mouhoun region

The artisans fabricated 19 threshers, of which 16 were sold to private sector service providers and three to farmer organizations. The project provided 60% matching grant to service providers and a 40% loan was accessed from CORIS Bank. The grant funds were deposited with the fabricator to build the ordered thresher, since they had little working capital. Of the 19 units, only 11 accessed the matching fund with 8 units paying full price. The cost per unit was 3,500,000 FCFA (US$6,364). The artisans provided post-sales maintenance support to all the equipment buyers for three months and trained the equipment operators.

Figure 4: Artisans fabricating a thresher in a workshop

The machine performance was demonstrated in the field with the participation of all major cowpea value chains actors, 26 field events with live threshing of crop in the project zone in the presence of 1,900 participants. The demonstration has been the most used means for the scaling up of the machine use and adoption. The machine was showcased at various fora including the World Legumes Day, the Forum for Science and Technology (FRSIT) in Ouagadougou in October, 2018, where the machine won a prize from the Ministry of Trade and Industry for the best innovation directed to rural communities.

Profitability of threshing operation

Thresher owners provided threshing services at a fee to farmers. Threshing cost ranges from 750 to 1000 FCFA per 100 KG bag (US$1.36-1.82/100kgs) or $0.013 - 0.018/kg.

An operational balance sheet (Table 2) threshing operation has been made based on field data. Calculations are made based on the following conservative assumptions:

- ✓ 60 days of effective work/operation per cropping season
- ✓ Depreciation time: 5 years
- ✓ Operator threshes at least 4 tons per day

Table 2: Threshing machine operational cost and profit

Designation	Quantity	Cost (FCFA)	Amount (F CFA)	Amount (USD)
Traction	60 days	2500	150000	270
Used oil	CFA	4000	16 000	30
Fuel	CFA	1861,8	111 708	205
Repair and maintenance charges	CFA	2000	120 000	220
Depreciation	CFA	5833	350000	635

Operator's salary	60 days x 1	2000	120 000	218
Helpers' salary	60 days x 1	1000	60 000	109
Total expenses for 60 working days			**927 708,00**	**1686**
Total expense for one working day			15461	28
Total revenue for 60 effective working days	**40bagsx60 days**	**1000**	**2 400 000**	**4,363**
Gross margin for 60 effective working days			1 472 292	2,676
Average gross margin for one working day			30 372	
Net margin for 60 effective working days			**1 122 292**	**2,040**
Average net margin for one working day			18 705	34

Reducing drudgery and job creation:

Traditional threshing of cowpeas is manual in these provinces, requiring 3 man-days of 10 laborers to thresh 1,000kgs of cowpeas. Women as well as men are involved in the process, with women carrying out the winnowing in addition to threshing. The machine has a threshing capacity of 1,500kg/hr. The quality of threshed grain is high with no broken grains and chaff, and no need for further winnowing. This reduces the drudgery and time spent in threshing. The saved time is used for other activities including growing vegetables under irrigation. Each machine requires two people to operate it, thereby creating 38 jobs from the 19 threshers sold, mainly for youths.

Reduced post-harvest losses

Losses during threshing were found to be highest during the winnowing stage of manual threshing. Grain obtained from mechanized threshing was of high quality, without broken grains and chaff. Farmers who used PICS bags and stored the produce in the aggregation centers managed by the FBOs, reduced post-harvest losses from 30% at baseline to 9%. This called for proper warehouse management protocols. . (The grain had to be dry (10-12%) moisture content).

Increased business opportunities and Access to finance/credit:

To better meet and satisfy cowpea demand, capacity building of farmers to improve production and post-harvest management at different points of the harvest was undertaken, including production structuring and linkage to off-takers. Farmers needed finance/credit during crop production and at harvest. With good market structuring through off-taker arrangements, two financing models were used.

Model 1: Off-taker driven: in this model, Agri-business actors (off takers) provide all inputs (seeds, fertilizers, pesticide, threshing, PICS bags.) and other needed services such as land preparation, post-harvest services to his clients and is reimbursed in kind at harvest. Commodities and services prices are agreed upon before implementation. In this model, the role of the project has been to link up willing off takers to farmer groups. Three (3) private operators were able to support 2,176producers, 1,851 of them women, in two seasons, supplying them with all the inputs and services needed and buying back the produce. To ensure farmers delivered the produce according to the off-taker standard specifications, the project trained the farmers in post-harvest management and negotiation and costing skills. This model is a win-win and self-sustaining as long as the farmers and the buyers honor the contract/engagement.

Model 2: Warrantage: In this model, farmers gather their commodities collectively in aggregation centers to build a stock that is used as collateral to secure loans or inputs/service through a financial institution. Four aggregation centers were set up with the participation of 2,227(1769 women) in two seasons. The model leveraged CFA 57,000,000 (US$104,000) under the warrantage system. The farmer organizations were able to pay their members a percent of prevailing market price on delivery and the balance paid after sales. Farmers kept their stocks and released it to the market when prices appreciated.
The above two models stabilize prices for farmers and reduce the intermediation layers (brokers) to reach the market, with farmers retaining the margins.

Mozambique Model, results and outcomes

Soybean demand in Mozambique has been on the rise, driven by the animal feed industry, where demand outstrips supply. 60% of Mozambique's soy requirements are met through imports from Brazil and Argentina. 80% of local production is from smallholders, with Zambesia contributing 55% of the supply. Low agricultural productivity in Mozambique is a major bottleneck in the country's agricultural sector. This results from limited access to and use of improved inputs or mechanization as well as poor agronomic practices and high post-harvest losses.

In order to address this, TechnoServe, in 2012, began developing the Small Commercial Farmer (SCF) model that focused on emerging farmers and/or trusted existing local small agribusinesses. They trained, supported, and equipped these SCF to deliver the necessary inputs, extension, mechanization, and other services like land preparation and threshing to smallholder farmers (SHF) on a commercial basis. In 2014, Technoserve further supported the establishment of a seed multiplier cooperative, Cooperativa de Produtores da Alta Zambézia (COPAZA) with 32 members in Gurue, Malema, Alto Molócué and Ribaué districts. The cooperative organizes SCF and plays a key role in marketing and advocacy for seed producers, SCF, and SHF clients. TechnoServe's support in Gurue also encouraged the program's seed multipliers to become bankable enterprises that may access loans. This new funding source enabled institutions to acquire technologies (e.g., tractors, threshers, irrigation, etc.) that contribute toward increased production. Furthermore, these technologies may be used for land preparation and mechanization services in neighboring smallholder farms. Further research working with COPAZA established that low yields were further hampered by post-harvest losses, which farmers experienced during threshing due to inadequate technologies and storage options. Constrained access to finance limited access to labor-saving technologies and storage options. These created major barriers for the productivity of SHFs. One of the key components of the SCF model was to bring mechanization to Mozambican farming communities. The time and manpower required to cultivate land in Mozambique is a major bottleneck in terms of agricultural productivity, and large farms are impossible to work entirely by hand. For most farmers buying mechanized equipment was not feasible without assistance, since most are imported.

As AGRA's implementing partner for this project in Mozambique, Technoserve leveraged this tested model in the implementation of the project in Gurue (high in soybean production and base of COPAZA), focusing on reducing post-harvest losses through mechanized threshing.

In the second component of the project intervention, TechnoServe supported the promotion of increased production and marketing of nutritious soy-based food products through targeted technical assistance and market linkages, specifically to female-owned micro-processing and micro-retailer groups.

Project approach

The Post-Harvest Technology (PHT) tested in Mozambique was only the thresher. One of the key components of the SCF model is to bring mechanization to the farming communities of Mozambique. During the post-harvest phase, the key area of mechanization was to replace manual threshing with mechanized threshing. Using the Small Commercial Farmer Model, described above, the project recruited 20 women through a call for proposal to acquire imported threshers from Brazil and provide threshing services to other farmers at a fee. The threshers cost $7,000 each. The project used blended finance to fund the threshers; a 50% matching grant,

40% loan from GAPI at 18% interest rate (standard rate is 30%) and 10% cash deposit from each of the 20 women SCFs.

The project aimed to achieve the following outcomes:

- Increased SHF productivity as a result of sustainable access to improved, affordable post-harvest mechanization services (threshing machines) through a SCF network
- Increased on-farm jobs in Gurue, particularly among women and youth who support threshing service provision
- Increased access to markets for SHFs and SCFs, particularly for producers of soybean derivatives
- Improved access to productive infrastructure and storage facilities for SHF

To reach these results, the project focused on two activities:

1. Recruit and Support 20 New SCF to invest in New Threshing Machines
2. SCF Training on Business and Marketing Skills, Equipment Use, and Service Delivery to Surrounding SHFs

Summary of key results achieved

No. of new SCFs acquire threshing machines to provide threshing services	20- all women
No. of SHF accessing threshing services from the new 20 SCF	282
No. of SCF trained in threshing services, management and equipment maintenance	83 (20 new SCF)
No. of farmers trained in post-harvest management and good agronomic practices	3,300 (110% of target)
No. of farmers aggregating soybeans (seed & grains)	4,999
Volume (MT) of soybean sold through aggregation centers	15,866
Value of soybean sold through aggregation centers	$4,683,617
No. of threshers imported	20 (target 20)
Loans accessed from GAPI to finance threshers	$ 56,000
Jobs created from threshing services	29

Table 3: key project data

Performance of imported threshers

The project identified 20 women to support on thresher acquisition through a call for proposals. Threshers were imported in two tranches of 9 and 11 because the beneficiaries were all not ready on time**.** The first batch of 9 threshers imported from Brazil through a local agent TECAP, worked well and owners are able to provide threshing services and service the bank loan. The 2nd batch of 11 threshers, imported through the local agent, Barloworld, had a manufacturing fault consisting of engine failure. The manufacturer sent replacement engines, but these arrived at the tail end of the threshing season in 2018. TechnoServe had to facilitate discussions with the financier GAPI to roll over the loan repayment to following season for the 11 SCFs. For the 9 SCFs whose equipment had no problem providing threshing services as the demand for services outstripped thresher availability.

Training of SCFs in business management and thresher maintenance

To equip the 20 SCFs with skills to manage the threshing business adequately, training sessions were held that covered business management and marketing, financial management, costing and negotiations. The thresher importers trained SCFs and the equipment operators on the running and maintenance of the threshers for soybeans and other crops like maize and rice to diversify the income streams and the different cropping seasons.

Reduce post-harvest losses and drudgery

Soy farmers, in general, would like to use mechanized threshing if available. However, the limited availability of the threshing machines was a key challenge: few machines, high demand, long waiting periods particularly for small farmers, leading to rotting and losses. PHT service providers always thresh their own fields first and indicated a preference for serving farmers with large plots, which is more efficient.

Since mechanized threshing is much faster than manual threshing, farmers using the former method do not incur high costs of food to feed the workers of manual threshing (which can take 20 days or up to a month). In contrast, mechanical threshing can take one day or two (depending on total yield) and only a meal is required for hired labour. All considered, mechanical threshers appear to have more advantages over the manual threshing.

Promote the Production & Marketing of Nutritious, Soy-Based Products

Consumption of soy-based value-added products in the rural area of Gurue is very limited. The most commonly found product is soybean flour, used in various products, albeit at low volumes. TechnoServe's strategy for promotion and marketing of soy derivatives products focused on restructuring the Cooperativa Nossara, a cooperative of women producing soy products located in the rural community of Ruace and the only group active in the area. Women in other communities were supported as long as they had a relationship with Cooperativa Nossara. Nossara was assisted to be legally registered as a cooperative. Membership increased from 5 to 32 based in Ruace (7), Lioma (7), Magige (5), Gurué (13).

A feasibility study commissioned by AGRA on soy processing in Mozambique reported very low level of processing. The study provided recommendations on soy products with good market potential, mainly soy flour, commonly used in baking and blended flour and soy milk, primarily promoted for school feeding program and for small babies. With support from the project, Nossara, sales of soy derivative products (cakes, soy milk, snacks) increased by 300% over target, with regular demand from the market. More support and technical assistance is needed to move Nossara Women Cooperative towards a solid business model and scale up. Support in marketing skills and product branding, financial management and machinery maintenance

Figure 5: Nossara Women Cooperative member: Baking soy products

Objective 2: Assess the effectiveness of select delivery models for the chosen innovations;

AGRA engaged two research firms, COWI in Mozambique and ISSER in Burkina Faso, to undertake adoption and impact studies of the project. During the three years of the project, ISSER and COWI conducted baseline surveys in 2016 followed by field monitoring visits in 2017 and end-line surveys in 2018. These aimed to assess the effectiveness of the delivery models in the adoption of the PHTs and the impact of the adoption on the lives of farmers, women and youth

The following were the guiding two research questions:

1. What is the most effective way of accelerating the adoption of soybean and cowpea post-harvest management technologies?
2. What is the economic and social impact of increased use of post-harvest management technologies (PHTs)?

In order to address the above questions, the researchers set out clear research design protocols and methodology, supported by the implementing partner in each country. The detailed endline reports from ISSER and COWI are annexed to this report (Annex 1 &2)

Key research findings in Burkina Faso

The study for Burkina Faso was carried out by ISSER in the region of Boucle du Mouhoun, specifically in the Sourou and Nayala provinces, targeting cowpeas. The target technologies were PICS bags and threshers. The study had two objectives: One was to examine the impact of introduction of PHT (PICS bags and threshers) on postharvest losses, welfare of small-scale farmers and other socio-economic indicators of small-scale farmers in the intervention region. The second objective was to ascertain which channel of delivery of PHTs is most efficient (Agro Dealers, Cooperatives, Private mechanized service providers

Theory of change

The underlying theory of change of the Project assumes that awareness and access to post-harvest technologies will increase adoption rate of PHTs, reduce crop losses, increase total harvest volumes and crop sales, allowing farmers to access better markets. Increases in these indicators are consequently expected to have a positive impact on food security and reduce incidence of hunger in farmer households as well as increase household incomes and prosperity.

Theory of Change for Burkina Faso intervention.

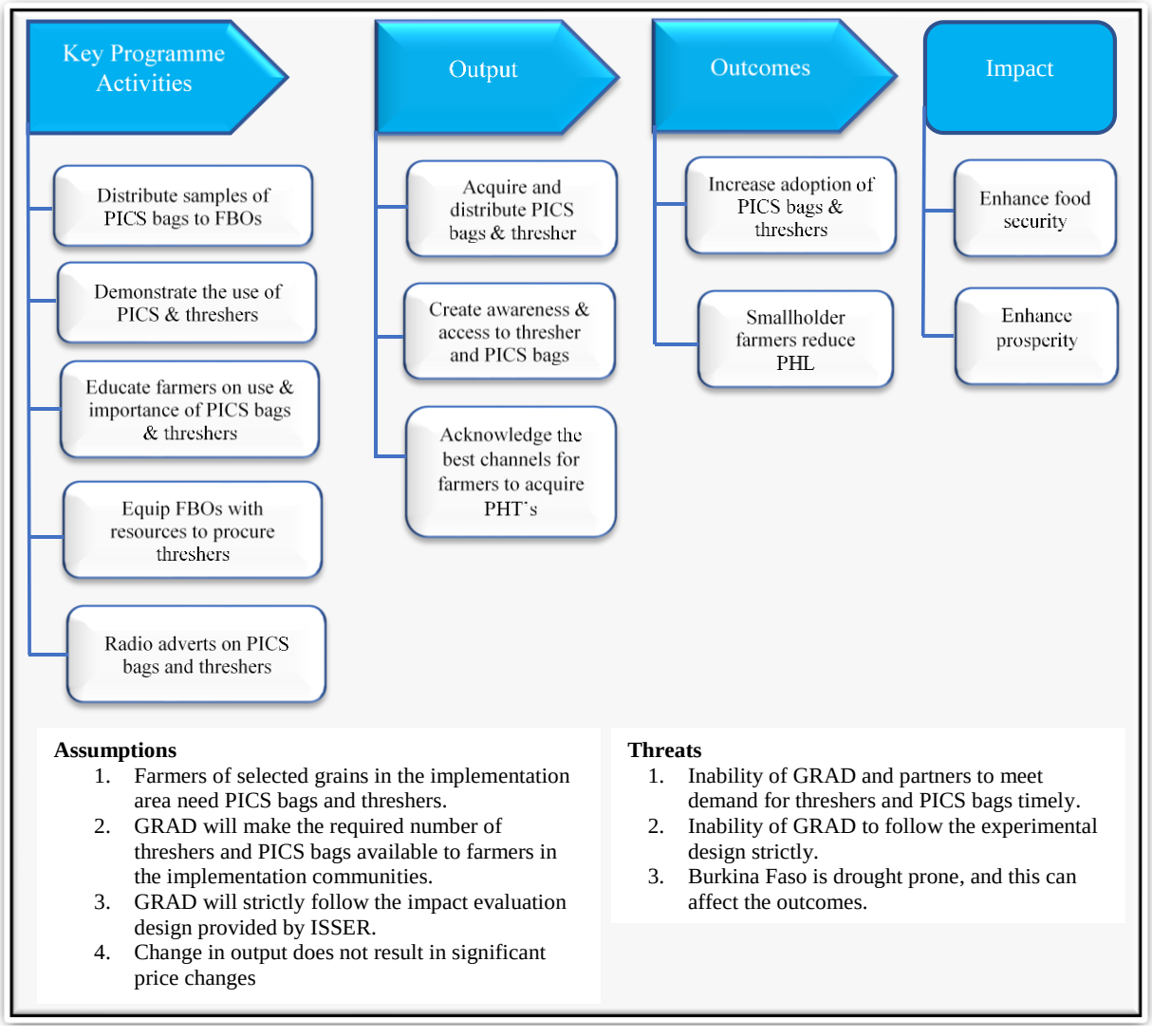


Figure: 6: Theory change - project in Burkina Faso
Source: Authors' construct (ISSER)

Survey design

The surveyed households were grouped using two typologies, one indicating whether or not the farmer has "heard of PICS bags or Used PICS bags", and the other one on whether a farmer has "Heard of threshers or Used threshers",

Research findings

A summary of the results of the two research questions is presented below:

1. What is the most effective way of accelerating the adoption of cowpea post-harvest management technologies? Towards accelerating adoption of PICS and threshers, the project established that the most effective way of scaling up the use of technologies was through training, demonstrations and structuring the distribution system through use of agro-dealers, especially for PICS. For machines, the

project determined that demonstrations of threshers with stakeholders was most effective to incentivize procurement and ultimate use of the machines.

2. What is the economic and social impact of increased use of post-harvest management technologies (PHTs)?

By structuring the distribution system for PICS bags, through by Agrodealers, the distance farmers travelled to access the PICS reduced from over 50km to 17.5 km, saving farmers time and travel cost

Farmers who used PICS bags did not sell their crop immediately after harvest but waited until prices appreciated. Using stored crop as collateral, they could access finance under the warrantage system.

As a result of reduced losses and high quality, farmers who used PHTs were able to access institutional markets like World Food Program (WFP) and SONAGESS (national food reserve agency) of Burkina Faso. These pay a premium price for quality product

One of the potential impacts of the introduction of the thresher machine is the creation of employment opportunities for local labour, mostly related to the operation and maintenance of the thresher machine and in the thresher fabrication workshops.

Use of threshers reduced drudgery. The equipment has a capacity of 1,500kg/hr. It takes 10 workers three man-days to thresh 1,000kgs of cowpeas, saving time for farmers to grow irrigated crops and other activities. Post-harvest losses were highest at winnowing stage and at storage, and least at threshing

Reducing food losses, and particularly PHL, contributes to improving food security, fighting hunger and reducing poverty. Measures aimed at reducing post-harvest losses (PHL), potentially have direct consequences for improving livelihoods and the welfare of both farmers and consumers

Post-Harvest losses at different stages along the chain

A major object of the project is a substantial reduction in postharvest losses of grains, and this goal was to be achieved via adoption of postharvest technologies – threshers and PICS – by smallholder farmers. The study assessed the impact of the intervention on total postharvest losses as well as postharvest losses at the threshing, winnowing and storage stages. It is expected that the introduction and subsequent adoption and usage of postharvest technologies will have a dampening effect on the overall postharvest losses and at the various stages of the postharvest process, especially in light of adoption and usage of these technologies., Overall, there was a decline in the postharvest losses between baseline and end-line. Total postharvest losses of the grains were observed to decline from an average of 20.87kg at baseline to 14.13kg at end-line at farmer household level, (46.8%), (surveyed households). Controlling all other factors, the decline can be attributed to the high adoption and usage of PHTs over the two cropping periods. . Overall, results indicate that PHTs reduce the quantity of the farm produce lost at the postharvest process in households surveyed as follows:

- There is no significant impact of the intervention on post-harvest losses at threshing level;
- At winnowing stage, the intervention reduced crop losses by approximately 9.6Kg on average among households surveyed.
- At storage stage, reduced postharvest storage losses by 51Kg on average among household surveyed

Significantly, the reduction in postharvest losses at the storage stage was more pronounced, an indication of the success of PICS bags usage across the treatment communities.

Table 1: Impact of postharvest technologies on postharvest losses

Variables	Threshing Losses		Winnowing Losses		Storage Losses	
	Eqn1	Eqn2	Eqn1	Eqn2	Eqn1	Eqn2
Treatment	10.396**	10.495**	9.031**	9.331**	48.973***	49.912***
	(4.089)	(4.189)	(3.789)	(3.910)	(10.193)	(10.535)
Time	0.000	-0.553	0.000***	0.507	1.143	0.973
	(0.000)	(1.400)	(0.000)	(0.531)	(1.140)	(2.184)
Treatment x Time	5.660	6.186	-8.746**	-9.571**	-49.936***	-51.293***
	(13.608)	(14.898)	(3.800)	(4.211)	(10.261)	(11.280)
Sex		-11.17**		-4.028**		-18.276***
		(5.507)		(1.866)		(5.244)
Age		0.072		0.031		0.629**
		(0.267)		(0.113)		(0.274)
Can Read		-4.166		4.700		19.120
		(9.374)		(4.113)		(14.104)
Can Write		2.173		3.171		9.061
		(6.844)		(4.545)		(15.100)
Observations	742	742	742	742	742	742

Robust standard errors in parentheses. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively

Distribution Channels testing

The project sought to ascertain the effectiveness of selected distribution channels of PICS bags and which channel enhances adoption of the technology. The project targeted four distributional channels for PICS bags in the intervention districts – farmer-based organizations (FBOs); agro-dealers; agriculture directorates (through extension services) and non-governmental organizations (NGOs).

The results indicate significant differences in the impact of the channels of acquisition on adoption of PICS bags in the intervention communities. The results suggest that acquisition from FBO has no impact on adoption of PICS bags among households in the intervention communities. Furthermore, overtime FBO channel of acquisition has not influenced households' decision to use PICS bags. In fact, distribution of PICS bags through FBO has negative impact on the probability that household gets information of PICS bags in the intervention communities .The probability of PICS bags adoption is relatively greater when sourced from agro-dealers relative to NGOs. Again, in relation to sources of information on PICS bags, agro-dealers have greater impact on the probability of household hearing of the technology. The study therefore concludes that PICS bags acquisition through agro-dealers has the potential to enhance adoption of the technology relative to other sources of acquisition

Key research findings in Mozambique

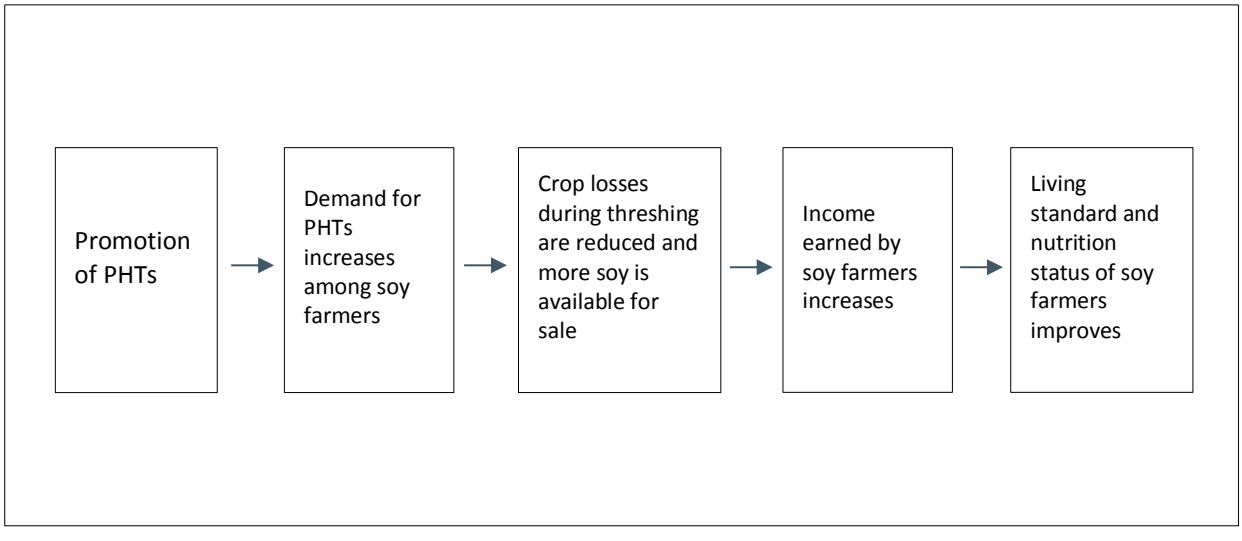
The research study for Mozambique was carried out by COWI. The study sought to identify the most effective way of accelerating the adoption of soybean post-harvest management technologies (PHT) in upper Zambézia,

northern Mozambique, more specifically in Gurué district. The selected PHT was the threshing machine. The second objective was to estimate the economic and social impact of increased use of PHTs in terms of production, income, nutrition, women's situation and youth employment. In addition to these methods, a cost-benefit analysis of the thresher machine was performed, along with the calculation of a food diversity index and a composite index on women empowerment in agriculture.

Theory of change

The underlying theory of change of the Project assumes that the promotion of PHTs will awake farmers´ interest and increase their demand for improved post-harvest technology, which in turn will lead to reduced crop losses and increased volumes of soy to be sold. Through greater sales, the farmers are expected to achieve higher earnings and thereby improve their living standards and increase their food intake.

Figure 7: Theory of change for Mozambique intervention



Survey design

Surveyed households were grouped using two typologies, one indicating whether or not the farmer used any thresher, and another classifying the farming households over time (persistent adopters if they used the thresher in both periods (2016/2018); disadopters if they used the thresher in 2016 but not in 2018; new adopters if they only used the thresher in 2018 but not in 2016; and non-adopters if they have never used the thresher).

Research findings

A summary of the results of the two research questions is presented below:

1. What is the most effective way of accelerating the adoption of soybean post-harvest management technologies?:It is noted that farmers are very positive about the thresher machine and eager to use it. However, the adoption of thresher machines for soybean is associated with both investment profitability and the financial capacity to buy the thresher machine, or to rent it from a local threshing service provider

2. What is the economic and social impact of increased use of postharvest management technologies (PHT)?: descriptive results of the study indicate that soy farming households who use the thresher machine attain higher productivity levels as they use improved inputs more frequently than non-users. As a result, they also market a higher proportion of their total production, become wealthier and have a more diversified food diet; comparatively to soy farming households who do not use the thresher

3. The cost-benefit analysis showed that, despite the high acquisition cost of a threshing machine (US$7,000), the investment in the thresher is found highly profitable in a 12-year life cycle with the thresher operating at almost full capacity 1500 kg / day, during 6 months per year) (thresh soybeans, beans, maize and rice). The financial capability to make the required investment of buying the thresher machine can limit the opportunity to expand adoption.

The level of operation capacity is the most critical factor for the profitability of mechanized threshers. The investment becomes non-profitable if the thresher operates below 120 days, and without AGRA grant. AGRA's subsidy makes the investment attractive, even operating at 50% capacity at a 15% discount rate. If AGRA's grant has to be progressively reduced the investment in mechanized thresher continues profitable, as long as, it manages to thresh 270 tons of soybeans and other grains per agriculture season, and the investor has the financial capacity to acquire the equipment.

One of the potential impacts of the introduction of the thresher machine is the creation of employment opportunities for local labour, mostly related to the operation and maintenance of the thresher machine. This extends to local agro-dealers and suppliers of mechanic services, who are sought for spare parts of the machine as well as repair services. Each machine requires a minimum of two people, an operator and an assistant. More labour is required from the plot owner to feed the machine. The thresher was found to be 6.5 times faster than manual threshing. This has encouraged farmers to increase their soybean acreage (on average from 5 ha at baseline to 21ha at endline (3 years).

Another impact of the thresher machine is the expansion of soy farming plots and the provision of threshing services to other farmers. Soy is perceived as one of the most profitable crops and therefore there is a motivation of increasing soy production as soon as the household can efficiently manage the harvest and post-harvest (sales) process.

One additional impact of the thresher machine is the freed labor time for both men and women: mechanized threshing works 6.5 times faster than manual threshing. Female household members in particular, are spared from the responsibility of cooking and catering for the manual threshing labour force (normally up to 5-9 people) which can stretch to 20-30 days in a season. The freed time of both men and female is applied in other activities both leisure and income-generating, e.g. growing horticulture crops and beans.

Finally, soy milk and other derivatives of soy appear to be well accepted locally. Although this market is at a nascent stage in the long run, this may imply that an increased use of soy could diversify the local diet and boost the nutrition level of local population.

To accelerate the adoption of PHT, it is argued that more affordable thresher machines should be made available in the market in order to facilitate investment in thresher machine business. One option would be to facilitate imports and the private sector entry into this market, to make thresher machines available at a relatively lower cost. Additionally, the development of secondary markets (markets of used thresher machines) and machinery-hire markets may also contribute to strengthen markets and expand supply of more affordable machines.

On the demand side, service provision on fee-for-use models (used in site) should be expanded, as well as increasing information on availability of thresher services possibly through information technologies.

Objective 3: Synthesize and disseminate evidence and lessons from the scaling efforts to catalyze the field and inform policy change and investment

The dissemination plan is work in progress. However, two Stakeholder Validation Workshops were held in Burkina Faso and Mozambique, respectively, to share the project results, experiences and seek feedback. The workshops were attended by a total of over 120 participants (50 in Maputo and 70 in Ouagadougou) including top government agriculture director/permanent secretary, development partners, NGOs, researchers, processors, and farmers. The stakeholders would like to see a scale up of this work and access to the technologies in the whole country, while a few donor agencies would like to collaborate to scale up the work (USAID in Mozambique). Another dissemination meeting was held in Nairobi, in AGRA offices, on 6th March, 2019, for the AGRA and IDRC staff and leadership,

A learning event for the implementing partners of the two countries took place in Burkina Faso to learn from each other and share experiences, accompanied by IDRC senior agricultural specialist https://youtu.be/4R0Ydsl2c2g

Other dissemination materials included videos of threshing operations, fliers on machine maintenance, radio advertisement spots to provide benefits of using PICs bags and threshers.

In Burkina Faso, the Directorate of agriculture has adopted the projects training manual on post-harvest management for dissemination to all extension officers in the country.

106 demonstrations of the use and benefits of PICS bags campaign took place in all implementation provinces of Sourou and Nayala.

Discussions with policy makers in the ministry of Agriculture was undertaken to reduce/remove Value Added Tax on PICS bags to make them more affordable to farmers or include these in the input subsidy package.

Discussions with Purdue University to increase the number of PICS distributors in Burkina Faso resulted in 3 more distributors appointed. This will make the bags more accessible, especially outside the big cities.

The thresher developed by the artisans in Burkina Faso was showcased at various fora including the World Legumes Day, the Forum for Science and Technology (FRSIT) in Ouagadougou in October, 2018, where the machine won a prize from the Ministry of Trade and Industry for the best innovation directed to rural communities

Project launch in both Burkina Faso and Mozambique, were advertised on the radio, and launch events presided by senior government directors of Agriculture, and attended by private sector actors and farmers and farmer

The project coordinator in Burkina Faso was interviewed by the international French Radio (RFI) on the project and outcomes of using threshers and PICS in cowpea value chain. The interview was aired worldwide. . http://www.rfi.fr/emission/20170401-innovation-service-producteurs-niebe-burkina-faso

The project also leveraged the mFarms platform to disseminate messages on extension and farmer organizational development, and market information by text and voice, thereby creating farmer awareness.

A scientific Writeshop took place from 5-8 March, 2019, amongst the researchers and implementing partners. The Writeshop was to expand on and disseminate insights from the socio-economic inquires through the production of knowledge nuggets and scientific publications. More specifically, it aimed at:

- Reviewing the impact pathways on the interventions in Burkina Faso and Mozambique;
- Refining and journal article titles, the research objectives, questions and hypotheses;
- Exploring the data and reaching consensus on analytical frameworks;
- Synthetizing achievements and lessons for presentation to AGRA and IDRC teams;
- Receiving feedbacks for improvement of final reports and learning products;
- Conducting literature review to discuss findings and identify areas of unique contribution to the literature;
- Writing knowledge nuggets
- Identifying adequate journals;

The proposed workplan towards dissemination include:

- Estimating determinants of PICS adoption and intensity models using discrete and count models
- Develop 2 draft peer reviewed journal papers and aim to publish within the next 12 months
- Develop at least 2 knowledge nuggets by June, 2019.

In Burkina Faso, dissemination materials were shared as below:

- To inform stakeholders on cowpea improved production and post-harvest management, 28 video sessions were held in the villages in Sourou and Nayala, showing how to use PICS bags and the benefits reaching 4,445 participants (3821 women)
- A manual for thresher operation and maintenance was developed and shared with stakeholders
- Mfarms ICT platform was used in Burkina Faso to disseminate messages on extension and farmer organization development. This benefited some technicians from the Provincial Directorates of Agriculture and Hydraulic Development (DRAAP) of Sourou and Nayala provinces (extension officers)
- Data from the project is feeding into the Ministry of Agriculture reports working with DRAAP.
- A Learning event with project team from Mozambique was held in October, 2018, in Ouagadougou to share experiences: https://youtu.be/4R0Ydsl2c2g :
- A stakeholder Validation Workshop was held on 19th February, 2019, where project findings and outcomes were presented to over 65 participants in Ouagadougou.

In Mozambique,

- TechnoServe presented the project outcomes at a Conference Event: Experiences from Developing the Soybean Value Chain in Mozambique. (November 8th 2018, Maputo). The event featured the Small Commercial Farmers Model developed by TechnoServe in Alta Zambezia in which the AGRA project and other donors are integrated.
- A stakeholder Validation Workshop event was held on 28th February, 2019, in Maputo, with about 50 participants to share project results and get feedback
- A video showing benefits of mechanized threshing operated by a woman Small Commercial farmer was shared: https://youtu.be/TVuhmdcoT30

- A video on soy derivative products processed by Nossara Women Cooperative was shared widely to market these products: https://youtu.be/tljtctb25Cw
-

Synthesis towards AFS themes

Increasing agricultural productivity (Availability)

AGRA and its partners greatly focused on increasing agricultural production through increases in yields and labor productivity. In Burkina Faso, 6,070 farmers participating in the program needed 179,208 MT of improved fertilizer blends and 18,926 MT of improved seed to be able to increase their yields on the 1,743.25 hectares allocated to cowpeas. AGRA and its partner GRAD Consulting contacted financial institutions to provide credit for inputs. A loan facility of USD 45,165 was mobilized from three micro-finance institutions (URCCOM, RCPB, APFI) to facilitate farmers' access to 66.5 MT of agro inputs (fertilizer and seeds) Results showed increase in productivity in fields that used improved seeds and fertilizers compared to non-users..

This demand for input was created through training of 843 farmers (74% women) on good agronomic practices and 104 demonstration plots (173% of project targets) in improved seeds and integrated soil fertility management technologies. The project also partnered with existing agro-dealers to raise farmers' awareness. These agro-dealers also contributed some inputs for demonstration plots in Nayala and Sourou province.

The project also leveraged the mFarms platform to disseminate messages on extension and farmer organizational development. This activity also benefited some technicians from the Provincial Directorates of Agriculture and Hydraulic Development of Sourou and Nayala provinces. They were trained on the implementation of demonstration plots (varietal tests, fertilizers tests, and production techniques).

In Mozambique soybean is harvested in May, maize in July and pigeon peas in October. Scaling up the adoption of threshing machines increases the efficiency of farmers as they engage in non-stop harvesting and post-harvesting activities of these three crops. Linkages were established with a local seed producer (SBS) and local grain traders (Alif Quimica). SBS is committed to purchase 200 MT of seed while Alif Quimica has the capacity to process 10,000MT of soybeans and maize.

Improving access to resources, and/or markets and income (Accessibility)

The project supported a farmer organization to attend three trade events. These events include: Sourou province agricultural promotion days held from 11 to 12 April 2017 in Tougan and organized by the Regional Chamber of Agriculture. In addition, there was the provincial cowpea fair organized on 28, 29 and 30 April 2017 in Kassan by the Sourou province women association called Yiyé. The last on improved seed open-day took place in Nayala on 19 May 2018. This event enabled the association to network and identified potential off-takers of their produce. Relationships were developed and purchase agreed upon for the following season.

The project facilitated farmers and service providers to access financial services, loans and technical support. Value chain financing model (off-taker finances farmers and paid in kind with crop at harvest) and warrantage (using aggregated stocks as collateral) were facilitated in Burkina Faso. All service providers were linked to financial institutions and loans worth US$ 113,000 accessed, while under warrantage farmers leveraged over US$103,000.

Improving nutrition (Utilization)

A feasibility study was conducted on the processing and marketing of soy-based products in Mozambique. Two product categories were found to be feasible including soy milk and soy flour and their derivatives. The project supported Nossara Women Cooperative to revamp a previous investment and expand membership to other districts. Capacity strengthening of the cooperative that includes maintenance of the equipment, finalize

installation, and training and support on initial activities to get them to scale boosted the operation., The demand for soymilk is good but mainly for school feeding projects. Late payment is a challenge and the project is supporting the women to diversify to more products and other off-takers like UNICEF. A market study has come up with products that have high demand including soya cakes, bread, bajjias.

Informing policy

The project held Stakeholder Validation workshops to share project results, experiences and challenges and pathways to scale. The government of Burkina Faso has prioritized post-harvest loss management. The government extension unit in the Ministry of Agriculture has adopted the projects' post-harvest training manual in its extension work. The thresher machine was showcased at various fora including the World Legumes Day, the Forum for Science and Technology (FRSIT) in Ouagadougou in October, 2018, where the machine won a prize from the Ministry of Trade and Industry for the best innovation directed to rural communities. Writeshop to produce journal articles, policy briefs and knowledge nuggets was held in March 2019 in Nairobi, Kenya. These will be disseminated widely through different channels including website links, publications, and in post-harvest management events. Results of this work will be shared with partners and governments in the 11 countries that AGRA is operating in. In Burkina Faso discussions were started with the Ministry of Agriculture to reduce or remove VAT on PICS to make the bags more affordable to farmers and include PICS in the input subsidy package. This is work in progress.

Project Outputs

The following are the key outputs of the project:

- Project Validation workshop report held in Ouagadougou on 19th February 2019:
- https://www.youtube.com/watch?v=-Ro2Aw02nok&feature=youtu.be
- Project performance video- Mozambique and Burkina Faso:
  Link: https://youtu.be/MKcJ01Ll3Jc
- Project Partners' Learning trip in Burkina Faso: https://youtu.be/4R0Ydsl2c2g
- : Video Small Commercial Farmer benefits of mechanical threshing:
  https://youtu.be/TVuhmdcoT30Video on Nossara Women Cooperative on benefits of soy derivative products

  https://youtu.be/tljtctb25Cw
- Interview of Project Coordinator by International France Radio (RFI) on the project aired worldwide.
  http://www.rfi.fr/emission/20170401-innovation-service-producteurs-niebe-burkina-faso
- Success story Video on Nossara women cooperative soy processing operation in Mozambique
- Success stories on benefits of mechanized threshing in Mozambique
- Fliers on the thresher and its operational benefits
- Feasibility study on soy processing and technologies in Mozambique

Problems and challenges

The implementation of this project in two geographies (Burkina Faso and Mozambique) faced diverse challenges, some of which could be mitigated and others were beyond project scope. The following are challenges encountered in each country:

Key challenges faced by the project partners in the project period include the following:

- The process of thresher redesign, fabrication and testing in the field with the stakeholders took two (2) years leaving only one (1) year for demonstration and marketing. This slowed down the pace of business development in Burkina Faso;
- Financial access for value chain operations has been very difficult for all the actors in Mozambique and Burkina Faso. This limited the farmers and artisans' ability to access inputs and to market produce where they needed advance cash pending delivery and payments;
- The cost of PICS was considered high by some farmers especially given that there are other agencies giving free PICS in Burkina Faso. This calls for better coordination among agencies to harmonize approaches for higher and sustainable technology adoption;
- The project was also affected by some periods of insecurity that slowed down project implementation in both countries;
- The process of importing threshers is long and arduous especially for small commercial farmers who needed support with the bank process. This resulted in delayed procurement of threshers. In addition, some of the imported threshers (11) had engine manufacturer faults and could not run, replacements were made although received at the end of the threshing season, thus affecting the ability of small commercial farmers to repay their bank loan installments.
- The PICS bags supply chain is very poorly structured with many shortages occurring throughout the year due to the poor performance of the sole certified fabricator and the sole certified distributors. The presence of fake hermetic storage bags, similar to PICs, deterred some farmers from testing the technology.
- Unavailability of spare parts and technicians to service the threshers in the field, taking about a week to send one from Maputo to the regions denied SCFs business opportunities.
- Slow legal process of restructuring the Nossara Women Cooperative to become registered.
- Lack of a contact directory of thresher service providers, making it difficult for, clients to call for threshing services from outside their locality. This resulted in long waiting list.

Lessons learned

The project had similar objectives for Burkina Faso and Mozambique but lessons differ in context and geography.

In Burkina Faso key lessons include:

- Scaling out and up mechanized post-harvest or land services by private small businesses is offering a huge opportunity for the Burkinabe agriculture transformation, youth employment and drudgery reduction for women.
- Producers are open to innovation, especially in the adoption of production technologies, but lack of resources (financial and material) limits their efforts;
- PICS bags at a lower cost would allow a wide adoption by producers
- Collective marketing through aggregation centers was proven effective in linking farmers to markets, especially the institutional ones like SONAGESS (food security agency), school feeding program and World Food Program (WFP)
- Private led thresher operations have been far more effective in delivering services to the farmers and in supporting and sustaining threshing business compared to cooperative or FBOs.
- Large scale institutional buyers e.g. WFP and SONAGESS engaged and bought from SHFs when produce was stored in PICS bags

- Skilling and empowering local artisans through trainings, coaching, action research and financial access is a sound way to rural mechanization and youth job creation as artisans and thresher operators.
- Different financing models for the value chain actors work if well-coordinated (off-taker model and warrantage)

Lessons from Mozambique include:

- Availability of threshers and timely thresher services encouraged farmers to increase their soya acreage from 5 ha to 21ha
- Imported threshers require a well-established support infrastructure to work smoothly (spare parts, maintenance and personnel)).
- Although traditionally women are linked to the activity of manual threshing of their fields, when you switch to the provision of mechanized threshing services, men take over and manage the threshing activity.
- To ensure the management and leadership of threshing activity by women commercial farmers, there is need to build their entrepreneurial skills There is good appreciation of soy based derivative products in Gurue when nutritional benefits are well understood.

Overall assessment and recommendations

- One recommendation is to consider giving at least one month from project end date to submit project report. The current requirement to submit the report on project end date is straining because activities tend to carry on up to last closure day. (e.g. harvest and sales were on-going and data needed to be captured, dissemination of findings had to be done after project ends.)

ANNEX 1 Burkina Faso Impact report

ANNEX 2 Mozambique Impact Report